JOURNAL OF THE PALAEONTOLOGICAL SOCIETY OF INDIA
VOL. 36, 1991, PP. 59-65

ON *KRISHNANIA* SAHNI & SHRIVASTAVA, A MID-PROTEROZOIC MACROFOSSIL

P.K. MAITHY
BIRBAL SAHNI INSTITUTE OF PALAEOBOTANY, LUCKNOW - 226 007

ABSTRACT

The Mid-Proterozoic (+ 1000 Ma) benthic macrofossil *Krishnania* is redefined along with critical assessment of later described similar looking forms *Vindhyavasinia, Longfengshania* and *Vindhyania* indicating that all of them are alike and synonymous to *Krishnania*. Two species of *Krishnania* viz., *K. acuminata* Sahni & Shrivastava and *K. multistriata* n. sp. are detailed from the Rohtas Formation around Akbarpur, Bihar. On basis of morphology possible affinity to Phaeophyta or Rhodophyta is suggested.

Key-words : *Krishnania*, Mid-Proterozoic benthic biota, algae, Semri Group, Vindhyan, India.

INTRODUCTION

Krishania was first reported by Sahni and Shrivastava (1954, p. 50) from the mid-Proterozoic (+ 1000 Ma) Suket Shale (Semri Group, Lower Vindhyan) exposed at Ramapura, Madhya Pradesh. A perusal of published literature shows that the fossils resembling *Krishnania* have later been described under different names *Vindhyavasinia* (Tandon & Kumar, 1977), *Longfengshania* (Du, 1982; Hofmann, 1985) and *Vindhyania* (Mathur, 1982) from the mid-Proterozoic sediments of India, China and Canada along with *Chuaria* and *Tawuia*. The present paper deals with the recent collection of *Krishnania* from the Rohtas Formation of the Semri Group exposed around Akbarpur, Rohtas District, Bihar and critical analysis of the previously known similar forms.

MATERIAL

The Rohtas Limestone is the youngest unit of the Semri Group, Vindhyan Supergroup. It is overlain by the Lower Kaimur Sandstone of the Kaimur Group, Upper Vindhyan. In the Akbarpur area, the Rohtas Limestone is exposed below the escarpment and has been mined extensively during the last four decades to feed the important cement factories. The limestone is thinly bedded and the individual beds are separated by carbonaceous shales of variable thickness. At the base, the limestone beds are thicker and finely laminated while towards top it becomes argillaceous and stromatolitic. The argillaceous portion is purplish in colour and show characteristic ripple marks and mud cracks.

The limestone bands are tightly folded. Asymmetrical folds are present. In thin section, the rock consists of calcite and prominent micaceous bands which are sometimes folded. These bands are different from the main calcitic mass, though calcareous material present on these bands are granulated showing thereby folding effects. The bands are also filled with microcrystalline calcite and quartz, which are very intimately mixed.

The described specimens are (Fig 1A, B) collected from the following localities belonging to the Rohtas Limestone, Semri Group (Lower Vindhyan) occurring in the uppermost part of the sequence in argillaceous portion (Fig. 1B).

Amjohre Pyrite Mine (24^0 43' : 83^0 59')

Murlipahar Hill (24^0 39' : 83^0 59')

Baulia Quarry (24^0 36' : 83^0 55')

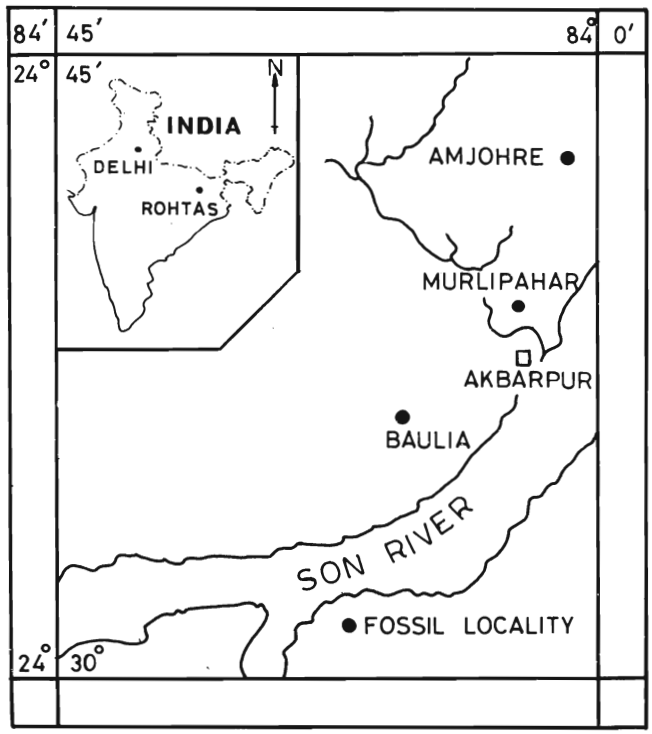


Fig 1A. Map showing location of samples

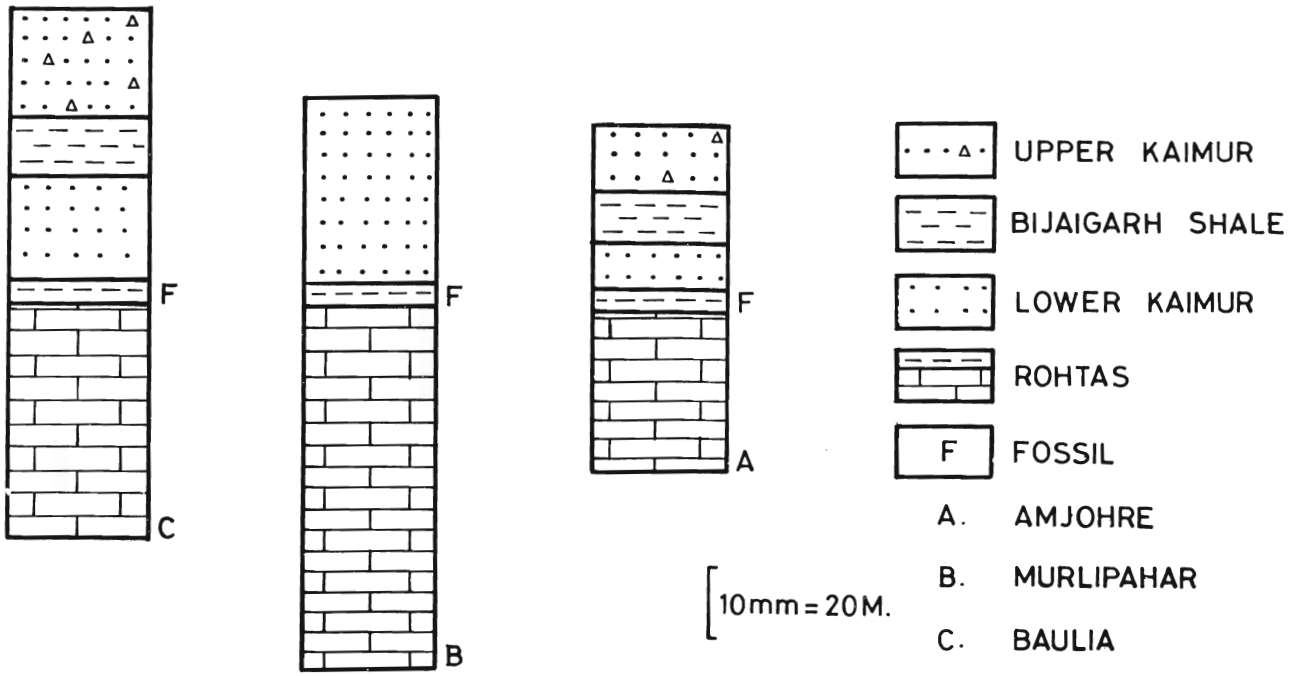


Fig. 1B. Lithocolumn of collection localities indicating fossil collection point.

The specimens are either carbonised impressions or moulds. No cellular structures were observed from the cellular pulls of the carbonised crust.

No radiometric dates are available for the Rohtas Limestone Formation, however, the underlying beds, the Basuhari Sandstone Formation in the adjoining area Chopan has been dated + 1125 Ma by Fission Track method by Srivastava, Rajagopalan and Nagpal (1985). Therefore, the beds of the Rohtas Formation are + 1000 Ma.

SYSTEMATIC DESCRIPTION

Krishnania SAHNI & SHRIVASTAVA, 1954 emend.

1954 *Krishnania* Sahni & Shrivastav;: p. 40.
1954 'Filament showing the funnel shaped end' Sahni & Shrivastava, p. 39.
1977 *Vindhyavasinia* Tandon & Kumar ; p. 127-128.
1977 *Krishnania* Sahni & Shrivastava in Sahni, 1977; p. 239.
1982 *Longfengshania* Du ; p. 27.
1982 *Vindhyania* Mathur ; p. 129
1984 *Longfengshania* Du in Duan & Du
1985 *Longfengshania* Du in Du & Tian ; p. 12-13.
1985 *Longfengshania* Du in Hofmann; p. 343-344.

Emended Generic Diagnosis : Bilateral flat fossils comprising of a foliate part abruptly constricting towards one end; in form of a narrow stipe-like structure ; margin of foliate part with or without rim, surface smooth or with fine thickenings.

Type species : Krishnania acuminata Sahni & Shrivastava, 1954.

Generic Description : Fossils preserved as external moulds or impressions. Distinctly divisible into two parts, a foliate part circular, circular-oval, oval or elongate-oval in outline. Surface smooth or structured with fine thickenings. Margin with or without border. Foliate part gets abruptly constricted at one end giving rise a narrow stipe-like structure, may be frail or rigid in nature and varying length, either shorter or longer than the foliate part. Surface may be smooth or structured. The rock preserving several specimens usually demonstrates a definite alignment indicating autochthonous fossilisation.

Discussion : Krishnania was originally erected by Sahni and Shrivastava (1954, p. 40) and later detailed by Sahni (1977) for acuminately ovate shape fossil, measuring 7-5 mm in its longest axis and 4 mm maximum in width; narrowing somewhat abruptly at one end but is evenly rounded at the other with a deep marginal furrow-more prominent on one, side and apparently continuous all round. Re-examination of *Krishnania* reveals that the specimen has actually been figured by the authors in reverse orientation. It

is now established that in reality three specimens are preserved overlapping one another and the central one is having a short stipe-like structure. A text-figure is reproduced here to demonstrate the fossil details (fig. 2A).

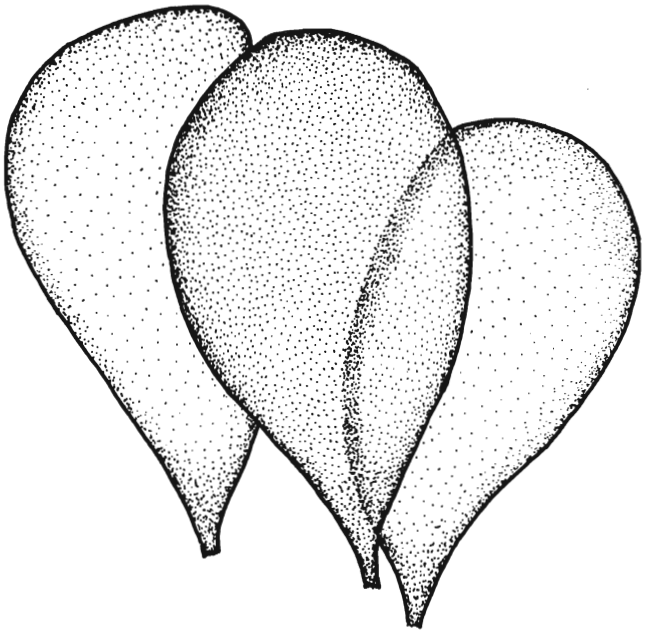


Fig. 2A. *Krishnania acuminata* Sahni & Shrivastava, x 3 (Redrawn after photographing type specimen)

The other fossil 'Filament showing the funnel shaped end' described by Sahni and Shrivastava (1954, p. 39, fig. 2) is also in no way different from *Krishnania*. In reality, it has a small terminal globular body with a long drawn stipe-like structure (fig. 2B).

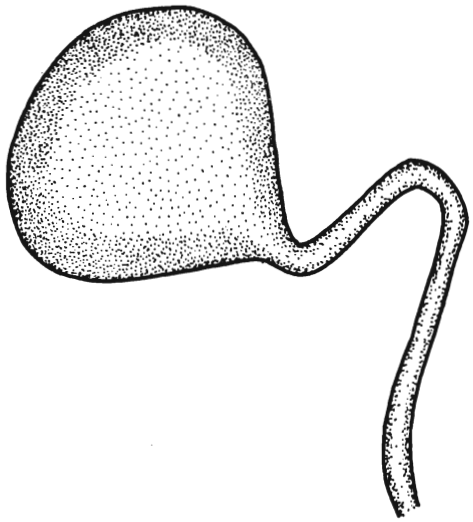


Fig. 2B. "Funnel shaped structure". x3.

Tandon and Kumar (1977; figs. 2,3) reported *Vindhyavasinia*, a minute specimen from the Rohtas Formation of Katni. This form was considered by them to be arthropodal in nature. In the past, doubts have been expressed regarding its affinity (Maithy, 1990). A critical re-examination of the specimen and photograph reveal the possibility for the presence of overlapping specimen of *Krishnania acuminata*. Similar overlapped specimen has also been figured by Hofmann (1985, pl. 38, fig. 4) from the Little Dal Group, Mackenzie Mountain, Canada. A new genus *Vindhyania* was proposed by Mathur (1982, fig. 3C) from the Suket Shale Formation, Ramapura, but no details or generic diagnosis were provided by him except for a photograph. As such, it is a *nomen nudum; however, from the photograph, it appears that it is in no way different from Krishnania acuminata.*

Du (1982) described a new genus *Longfengshania* from the Changlongshan Formation of Quingbaikou System (Middle Proterozoic) of China. Later from the above mentioned formation five more species were reported by Duan and Du (1984) and Du and Tian (1985). The body of the fossil consists of a foliate part and a parastem which looks like a stalk. In cases the foliate part is either smooth (*L. stipitata* Du) or with thickenings (*L. gemmiforma* Du & Tian). Basing on their description and photographs, it is visualised here that *Longfengshania* is a junior synonym of *Krishnania*. The figured specimen of *Longfengshania stipitata* described by Hofmann (1985, pl. 38, fig. 4; text-fig.5) indicates that many of the established species by Du (in Duan & Du, 1984, Du & Tian, 1984) are not tenable on morphological grounds, particularly on the basis of outline which is a variable character. The figured specimen by Hofmann (1985) preserves *L. stipitata* (figs. 6,10 & 13), *L. ovalis* (figs. 1-3 & 9) and *L. elongata* (fig. 5,7,9) shaped forms together, supporting the above contention that they are morphological variants of the same species. In view of this, all the above mentioned species are considered here to be synonymous with *Krishnania acuminata*.

Maithy and Babu (1988) reported *Longfengshania stipitata* Du (Pl. II, figs. 2,3) and a new species *Longfengshania chopanensis* (Pl. II, figs 4,5) from the Rohtas Formation of Chopan. A re-examination of the specimens show that most of them show a distinct circular scar at the posterior end. This feature is totally absent in type specimen of *Krishnania* supporting that the specimens reported by Maithy & Baby (1988) represent a different groups of

body fossils, therefore, and are here kept separate from *Krishnania*.

Affinities : Sahni and Shrivastava (1954) considered that *Krishnania* in its general organisation resembles to *Lingula*, but they further considered this similarity to be a superficial one. 'Filament showing the funnel shaped end' found along with *Krishnania* was considered by the above authors to be a possible algae. Du and Tian (1985) considered it to be algal in nature belonging to Phaeophyta or Chlorophyta. According to them the apical foliate part being used for photosynthesis and the basal part parastem for support attached to rhizome. Hofmann (1985) due to its clustured appearance and subradial arrangement expressed the opinion that the taxon represents a colony of rather complex organism of its age possibly an algae, phaeophytic or rhodophytic affinities compares to the modern algae *Holosaccion*. Recent collections from the Indian Vindhyan too support for algal nature as in gross morphology.

Krishnania in its overall organisation resembles *Drydenia*, the Devonian Algae reported from the marine sediments of New York by Fry and Banks (1955). *Drydenia* has elliptical laminae (8.5 cm long) with a narrow stipe and a branched holdfast. *Krishnania* differs from it in only being smaller in size and the absence of branched holdfast. Taylor (1981) considered *Drydenia* to be Rhodophyta while Stewart (1981) opined it to be a member of Phaeophyta. This analogy also supports *Krishnania* to be the oldest benthic algal forms.

The unidirectional preservation of the fossils indicates that they were growing near sea margin in a shallow shelf-like marine setting. The organisms were attached to the rock substratum by their stipe-like structures possibly developing into small rounded holdfast (fig. 3). Thus, the organisms are the record of the oldest forms demonstrating advanced body organisation considering the development of holdfast, the anchoring device enabling the organisms to resist their dislodgement by wave action; their bilateral symmetry standing upright from ground an advantageous organisation for absorbing sunlight and gaseous exchange in open atmosphere and the presence of well defined anterior and posterior organisation.

Krishnania acuminata SAHNI & SHRIVASTAVA, 1984 emend.

1954 *Krishnania acuminata* Shani and Shrivastava; p.40, fig.4
1954 'Filament showing the funnel shape end' Sahni & Shrivastava p. 40, fig.2.
1977 *Vindhyavasinia misrae* Tandon & Kumar ; p. 127-128, figs 2, b, c.

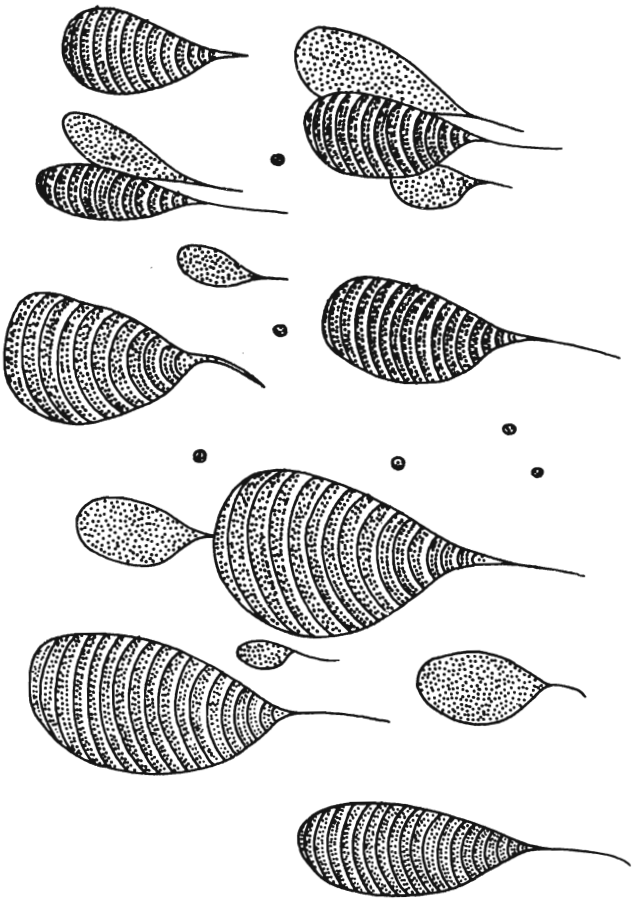


Fig. 3. Reconstruction to show possible habitat of *Krishnania*.

1977 *Krishnania acuminata* Sahni and Shrivastava in Sahni; p.239-294 Pl. III, fig.4, text-fig. 1a.
1982 *Vindhyania jonesi* Mathur ; p 129, fig. 3C
1985 *Longfengshania stipitata* Du in Du & Tian ; p. 12-13, figs 1-5
1985 *Longfengshania ovalis* Du & Duan, 1984 in Du & Tian; p. 12-13, figs 1-5.
1985 *Longfengshania elongata* Du & Duan, 1984 in Du & Tian; p. 12-13, figs 6-9.
1985 *Longfengshania elongata* Du & Duan in Du & Tian; p. 12-13, figs 11,12.
1985 *Longfengshania stipitata* Du in Hofmann; p. 334-344, Pl. 38 fig 4; text-fig.5.

Holotype : SAHNI & SHRIVASTAVA, 1954, fig.2.

Isotype : 35968 BSIP Museum, Lucknow

Emended Diagnosis : Foliate part elongate to oval, surface smooth, contracted end extending into stipe-like structure, marginal rim not pronounced.

Description : The specimen of *Krishnania acuminata* show variations both in size and shape particularly the foliate part. The figured specimen (Pl. I - 1) is nearly identical to holotype. Two fossil impres-

sions are superimposed. The upper one is incomplete and its basal part is missing, whereas the lower one is complete. The foliate part is ovate in shape, its longest axis, measuring ± 6 mm and maximum width is ± 3 mm. It narrows somewhat abruptly at one end and is drawn into a narrow stipe-like structure, measuring ± 2 mm in length. The other specimen (Pl. I-- 2-4) is larger in size measuring 10 mm in length and 6 mm in width, narrow stipe arising out of attenuated point, measuring 10 mm in length and 1 mm in width.

Locality & Horizon : Murlipahar, Rohtas District; Rohtas Formation, Semri Group.

Krishnania multistriata n. sp.
(Pl. I— 5-8)

Holotype : 35919 BSIP Museum, Pl. I, fig. 5.

Diagnosis : Foliate part ovate, surface with fine thickenings, attenuated end of foliate part drawn into a narrow stout stipe- like structure.

Age : + 1000 Ma. (After Shrivastava *et al.* 1985)

Description : Thirty specimens are preserved in one alignment in an area of 17 x 13 cm showing their size variations, The smallest specimen measures 8 mm in length and 3 mm in width and the largest specimen measures 25 mm in length and 12 mm in width. Surface of the foliate part with fine transverse thickenings with fine ridges and grooves. The surface of stipe-like structure presents rough appearance.

Comparison : The present species differs from the previous known forms of *Krishnania* in possessing pronounced surface thickenings and stout appearance of stipe-like structure. Previous known species have only smooth foliate part and frail stipe-like structure except *Krishnania (Longfengshania) gemmiforma* Du & Tian, 1985 emend. which shows small polygonal thickenings.

Locality : Baulia Limestone Quarry, Rohtas District.

Horizon : Rohtas Formation, Semri Group, Lower Vindhyan.

CONCLUSION

Krishnania, a benthic macrofossil found in association with the middle Proterozoic planktonic biota *Chuaria* and *Tawuia* provides an important glimpse of the macroscopic life in the ocean thriving about 1000 million years ago. The genus *Krishnania* demonstrates the presence of oldest macrofossil occurring in a shallow shelf-like marine setting alongwith free planktonic forms. However, *Krishnania* demonstrates much advanced organisation due to its bilateral symmetry and benthic habitat. The presence of such advanced organisation in the macrofossil indicates that the multicellular diversification of biota must have started much earlier, possibly at 2000Ma ago.

REFERENCES

DU RULIN, 1982. The discovery of the fossil such as *Chuaria* in the Qingbaikou System in northwestern Hebei and their significance. *Geol. Rev.*, **28** : 1-7 (in Chinese)

DU RULIN, & TIAN LIFU. 1985. Algal macrofossils from the Qingbaikou System in Yanshan Range of North China. *Precambrian Res.*, **29** : 5-14.

DUAN CHENGHUA & DU RULIN, 1985. Megascopic Palaeoalgae. In : Xing Yusheng (Editor). *The Palaeontology and its stratigraphical significance in Upper Precambrian of China* (in Chinese).

FRY, W. & BANKS. H.P. 1955. Three new genera of Alage from the Upper Devonian of New York. *Jr. Palaeont.* **29** (1) : 37-44.

HOFMANN , H.J. 1985. The Mid-Proterozoic Little Dal Macrobiota, Mackenzie Mountains, north-west Canada. *Palaeontology*, **28** (2) : 331-354.

MAITHY, P.K. & BABU, R. 1988. The Mid-Proterozoic Vindhyan Macrobiota from Chopan, southeast Uttar Pradesh. *Jr. geol. soc. India*, **31** (6) : 584-590.

MATHUR, S.M. 1982. Organic materials in the Precambrian Vindhyan Supergroup. In *Geology of Vindhyanchal*, edited Valdiya K.S. *et al.* : 125 -131 : Delhi, Hindustan Publishing Corpn. (India).

SAHNI M.R. 1977. Vindhyan palaeobiology, stratigraphy and depositional environments ; a critical review. *Jr. Palaeont. soc. India*, **20** : 289-304.

SAHNI, M.R. & SHRIVASTAVA, R.N. 1954. New organic remains from Vindhyan System and the probable systematic position *Fermoria* Chapman. *Curr. Sci.*, **23** : 39-41.

SHRIVASTAVA, A.P., RAJAGOPALAN, G. & Nagpal, K.K. 1985. Fission track ages of Lower Vindhyan glauconite beds at Mirzapur district (U.P.) *Indian J. Earth Sci.*, **12** (2) : 89-92.

STEWART, W.N. 1981. Palaeobotany and the evolution of plants. Cambridge University Press. *Cambridge.*

TANDON, K.K. & KUMAR, S. 1977. Discovery of annelid and arthropod remains from the Lower Vindhyan rocks (Precambrian) of Central India. *Geophytology*, **7** (1) : 126-129.

TAYLOR, T.N. 1981. Palaeobotany : an introduction to fossil plant. M C Graw Hill, New York.

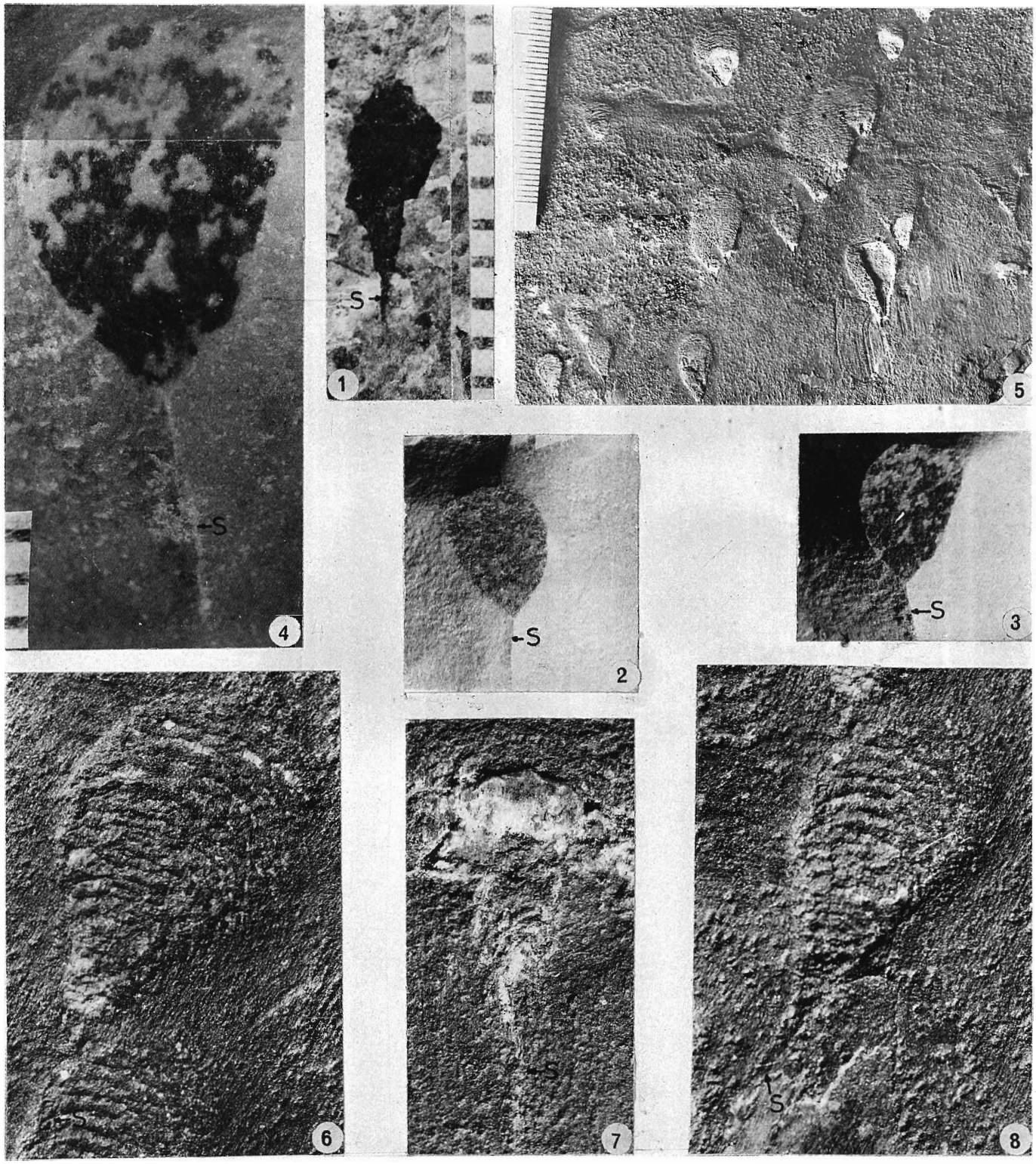
EXPLANATION OF PLATE

PLATE I

(Figs 4 and 6-8 are enlarged according to the scale given in fig. 4).

1. *Krishnania acuminata* Sahni & Shrivastava, Two specimens are preserved overlapping one another, the upper one is incomplete while the lower one is complete; BSIP 35968. (1 division is equal to 1 mm).
2. *Krishnania acuminata* Sahni & Shrivastava, ovate specimen with distinct narrow stipe-like structure(S), BSIP 36516; x i.
3. Counterpart of the specimen figured in Fig. 2; x i.
4. The specimen of figure 3 is enlarged to show stipe-like structure(S).
5. *Krishnania multistriata* n.sp. Several specimens on bedding plane showing varying sizes, BSIP 35919.

6-8. Specimens figured in fig. 5 are enlarged to show body thickenings and narrow stipe-like structure (S).


S
1
5
S
4
S
2
S
3
6
S
7
S
8